Telecommunications/ transportation substitution and energy conservation

Part 2

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Part 1 of this article reviewed existing research both on attitudes toward telecommunications substitution for travel and on operational experiments with teleconferencing and telecommuting. Part 2 examines major factors influencing substitution, including government policy. It concludes that government policy can significantly facilitate telecommunications substitution for travel and, indeed, the achievement of any real measure of substitution may depend upon proactive government policy. However, this is an unlikely prospect in the current US national policy environment.

Keywords Telecommunications, Transportation, Energy

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Although other factors might be influential, the research suggests that six major factors influence potential individual and organizational users' decisions about whether telecommunications could substitute for travel [1] These are (1) the nature of the meeting or the job, (2) the quality and availability of the technology, (3) the comparative cost of the alternatives, (4) the individual and organizational incentives and costs for substitution, (5) the availability and cost of energy, and (6) the politics of communications and of telecommunications arrangements

Analysis of factors influencing substitutions

Nature of the meeting or job

The needs of users are extremely significant in determining whether telecommunications can substitute for travel Several authors have noted that there is a widespread myth among potential user organizations that video is necessary for teleconferencing, and the high cost of video discourages further inquiries into narrowband teleconferencing [2] Whether this myth is a product of the user organization's own creation or of images created by video promotion is unclear What is clear from current research is that the most frequent reason given for business travel is 'information transmission', and the items most frequently transmitted are documents or letters As noted by Cordell and Stinson, [3] this may explain the relative 'popularity of audio and facsimile devices over video facilities in both the Bell Canada and OECD surveys' The research has also indicated that teleconferencing systems are effective for meetings involving simple information exchange, routine decision making, and moderately complex communications among people previously acquainted By implication, then, teleconferencing systems are relatively ineffective, compared to

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face-to-face meetings, for more complex communication and for meetings between people who are not previously acquainted.

The number of meetings held during a business trip is also an influencing factor. Most business trips are multipurpose, with 2.7 meetings occurring during one trip, as well as personal meetings (with friends, relatives, sight-seeing groups, etc) It seems likely that the multiplicity of meetings during most trips is a function of the individual traveller's assumption that all possible use should be made of the travel event, perhaps to the point of including unnecessary meetings One advantage of teleconferencing in this regard is that it allows 'for more discrete interaction as needed' [4]

Quality of the technology

The quality of telecommunications systems (or the problems associated with the systems) is also an important factor influencing substitution Audio teleconferences, or conference calls, are commonly criticized for acoustical problems such as feedback, reliability and voice quality, and for protocol problems like that of determining the order of speaking when there are no visual cues Voice-switched systems, designed to address the latter problem by transmitting only the dominant or loudest voice, have their own problems They may discourage some members of the conference from participating, inhibit a free-flowing conversation, make it difficult for some people to 'take the floor', and permit the current speaker to be interrupted by anyone with a louder voice

Yet, despite these objections, audio conferencing is relatively popular, due in part to certain characteristics of the systems For example, Bell conference calling presently allows simultaneous interconnection of up to 58 locations across North America. It is used mainly to transfer highly specialized information, and most frequently is used for less than one hour at a time [5]

In contrast, the characteristics of video conferencing are more problematic Video teleconferences are plagued by the awkwardness (or impossibility) of connecting more than two video conference rooms simultaneously, limited availability (since most systems are private), and limited interconnection among cities (until recently, AT&T's Picturephone® Meeting Service was available in only five cities; it is now available in 12 cities and is being extended to 31 cities)

While video teleconferencing adds the dimension of visual contact, it fails to compete effectively with face-to-face meeting, because 'the visual image does not provide the same atmosphere, or intimacy, of real contact'.[6] The most serious drawback, however, is the inability of most current systems to transmit documents – a primary need of most business meetings.

The technology is expected to undergo major changes in the 1980s in the USA as a result of the introduction of satellite systems to transmit information.[7] For example, Satellite Business Systems (SBS) expects to introduce a total communication network system that will go beyond data transmission to include facsimile transmission, audio and video teleconferencing.[8] Data will be transmitted from the sender's ground station to satellite and back to the receiver's ground station with unprecedented speeds SBS plans to concentrate on the very large corporate and governmental users, and initially expects 75% of the communications traffic to be voice and 25% to be made up of high-speed data for facsimile, computer and data terminal traffic, and teleconferencing.

[1]Some authors (R C Harkness, *Technology Assessment of Telecommunications/ Transportation Interactions*, Vol I and Vol II, Stanford Research Institute, Menlo Park, CA, 1977, R Johansen, J Vallee, and K Spangler, 'Electronic meetings Utopian dreams and complex realities', *The Futurist*, Vol 12, October 1978, pp 313–319) take a different approach and focus on the 'barriers' or 'limiting factors' to greater telecommunications substitution The problem with this approach is that it tends to assume that no changes are required by the telecommunications industries themselves, or that the current barriers have no legitimate basis in human behaviour, organization practice, or government policy The approach taken here is to discuss various influencing factors without particular bias towards whether they represent 'barriers' or 'opportunities' This approach is similar to that taken by Cordell and Stinson (A J Cordell, and J Stinson, 'Travel and telecommunications survey results to date and future possibilities', backgound paper prepared for the Science Council Committee on Computers and Communications, Science Council of Canada, Ottawa, 1979) and, in fact, draws heavily from their analysis as well as others

[2]Harkness, *op cit*, Ref 1, Johansen *et al*, *op cit*, Ref 1

[3]*Op cit*, Ref 1

[4]*Ibid*, p 18

[5]*Ibid*, p 15

[6]*Ibid*, p 16

[7]AT&T also is diversifying its voice communication network to include a broad range of computer communications functions, to enhance communications compatibility among different types of terminals, and to offer traditional data processing capabilities (eg message formatting, storage, and distribution capabilities, systems security, failure recovery, etc) See Cordell and Stinson, *op cit*, Ref 1

[8]SBS involves three partners Information Satellite Corporation (IBM), Comsat General Business Communications, Inc (Comsat General), and Aetna Satellite Communications, Inc (Aetna Life and Casualty)

Cordell and Stinson feel that the emergence and implementation of SBS may 'dramatically affect the extent to which telecommunications are used as an alternative to travel' [9] They argue that once an organization has bought into a system the incremental costs of additional service, such as teleconferencing, will be minimal Consequently, they feel that, with rising energy costs and competing pressures on time, potential travellers may have to prove that a trip is necessary as opposed to using the telecommunications facilities that already exist as an overhead cost to the organization

Since there is no experience with these communication networks, it is difficult to evaluate how extensively and how rapidly they might influence substitution It is likely the influence will be less extensive and less rapid than is suggested by current projections based on essentially promotional literature from the network providers

Comparative cost of alternatives

Research on the comparative cost of telecommunications and travel has generally shown that telecommunications is less expensive (and less energy consumptive) than travel But the results vary by type of technology. The various cost studies show video teleconferencing to be at a serious disadvantage compared to audio and computer teleconferencing For example, Picturephone® Meeting Service is five times as expensive as audio teleconferencing for comparable distances [10] The only alternative with which video teleconferencing compares favourably is travel, but even then not always. The relative cost advantage of video teleconferencing over travel depends upon the number of people involved, their locations, and the length of the meeting For example, video teleconferencing is considered more effective than travel only for meetings of less than three hours Cost clearly is likely to be a limiting factor in the use of video teleconferencing in the future – even if the technology improves

While telecommunications has an obvious cost advantage over transportation in the kinds of comparisons made in the research, it suffers from a severe and often overlooked cost disadvantage Transportation infrastructure already exists, telecommunications infrastructure, of the kind needed for widespread substitution to become feasible, does not exist There have been no studies of the public and private costs of providing such infrastructure, nor have there been studies which indicate the carrying capacity of the current telecommunications infrastructure Thus it is unclear, if people chose to make a shift, whether and how well they could be accommodated with the existing infrastructure, what additional capacity would be needed to provide for various levels of use, and what such capacity would cost This blindness to the costs (and to diffusion time requirements) is a major weakness of most studies and technology assessments of telecommunications substitution

Individual and organizational incentives

There appear to be very few incentives for individuals or organizations to substitute telecommunications for travel For example, several authors[11] have identified the following barriers to greater substitution of telecommunications

- Commuting costs are not internalized by organizations, thereby giving them little incentive to reduce commuting among their employees

[9]It might and then again it might not For example, at the time Cordell and Stinson made their statement they expected that both SBS and Xerox Telecommunications Network (XTEN) would be implemented However, since that time XTEN has been cancelled The cancellation serves to illustrate how tentative and problematic are forecasts about the technology and its implementation, let alone its performance once implemented

[10]R Johansen, J Vallee, and K Spangler, *Electronic Meetings Technical Alternatives and Social Choices*, Addison-Wesley, Reading, MA, 1979

[11]Harkness, *op cit*, Ref 1, Johansen *et al*, *op cit*, Ref 1, Johansen *et al*, *op cit*, Ref 10

- Formal salary scales for jobs prevent managers from offering lower salaries to teleworkers to offset communication costs
- For one employee to work remotely, it may be necessary for the organization to provide teleconferencing terminals for all those with whom he communicates, as well as to replace a large portion of the organization's paper flow by office automation Such costs may be difficult to justify in terms of the benefits of telework alone
- Contracting practices, which treat telecommunictions as overhead but permit travel as a direct cost, reduce the incentive to lower travel costs
- Communications technology is not seen by top executives as an important consideration in decisions about where to locate Communications is treated as a utility in organizations and made the responsibility of lower-level managers. As a consequence, communications technology issues and opportunities are rarely explored, or considered 'sufficient' motivation, in decisions to locate or relocate At the same time, however, 'human communication' often is a major consideration in the decision *not* to relocate, ie because valuable existing person-to-person relationships would suffer

While organizations might save money by means of reducing travel, space expansion, and heating and cooling needs through greater use of telecommunications, the savings are likely to be slight in comparison to the cost of providing the telecommunications infrastructure And the energy savings that would result from less employee commuting is not likely to be seen as cost-justifying, since the benefits would accrue to society as a whole rather than to the organization Consequently, managers generally are not motivated to seek telecommunications alternatives What would motivate managers, however, is demonstrated proof that substantial worker productivity results from greater use of the technology In the few operational experiments with telework that we examined, the major organizational benefit (and motivating force) seen by managers was increased worker productivity Increased productivity in telework resulted from employees. working longer hours, working more efficiently (with telecommunications aids that increased personal efficiency), working more effectively (with greater concentration, fewer distractions, faster work), working with greater personal motivation (to overcome limitation of physical handicap, to increase free time when time is under the individual's control, or to express appreciation for flexible working hours – eg single parents), and working because the technology 'is there', a reminder of work Although reliable measures of increased worker productivity from telework are non-existent, managers expressed notions such as 'it's a lot greater than you would think', 'it paid back the infrastructure costs in one month', 'it resulted in a one-time productivity increase of 10 percent', and 'workers self-rate their increased productivity at 10–12 percent' One enthusiastic manager expects a '200–300 percent increase in worker productivity' [12] One thing that is clear then, from the attitudinal and operational studies conducted to date, is that the idea of increased worker productivity is a major key to influencing organizations to substitute telecommunications for transportation, and hence to achieving increased energy conservation on any meaningful scale.

Another major incentive for organizational managers to adopt telecommunications is competition and/or emulation Research on the diffusion of innovations, and some of the exploratory work with office automation and teleconferencing, indicate that to the extent that some

[12] T Ottman, telephone conversation, 24 March 1981

leading firms in a particular industry move towards greater substitution of telecommunications, others will be drawn to do the same even if the benefits of substitution have not been clearly demonstrated This occurs because some firms fear that they might lose their competitive edge, fail to take advantage of an opportunity which might give them a competitive edge, or simply fail to stay abreast of the competition

The emulation phenomenon has been observed among government agencies, as when adoption of telecommunications by federal military agencies paves the way for its adoption by federal civilian agencies, and when these adoptions pave the way for adoptions by state and local governments Such emulation is not induced by competition, but by having the way paved by another agency which perfects the application, reduces the risk in adoption, and demonstrates the benefit to be derived The 'image' implications of being at the technological forefront or, alternatively, of not keeping up with advances in technology, are also an inducement

Availability and cost of energy

It is obvious that both the availability and cost of energy affect the extent of telecommunications substitution for transportation As liquid fuel is depleted, the price of oil can be expected to continue its upward climb, and this will have direct effects on the costs of transportation for all modes: air, rail, bus and auto Therefore, telecommunications may become increasingly attractive for profit-oriented corporations and cost-conscious governments In addition, a shortage of liquid fuel might stimulate the public to demand greater use of telecommunications and to make greater investment in telecommunications as a means of increasing energy conservation The fact that telecommunications uses electric energy rather than liquid fuel also represents a potential stimulus towards greater substitution while electricity has to be generated somehow, the alternative means of generating it are several – oil, coal, renewable hydro, thermal stations, and nuclear fission Thus, with liquid fuels increasing in cost and their sources of supply becoming increasingly vulnerable, a switch to electrically based telecommunications might become more and more attractive [13]

Politics of communication and telecommunications arrangements

A less obvious factor influencing substitution is the politics of communication, and of telecommunications arrangements Communication is a complex phenomenon, involving a variety of rules, assumptions, and perceptions which are often less than conscious, and which are primarily for meeting in person Therefore, when someone chooses to hold a teleconference, for example, the old rules for meetings must be revised Choices about whom to invite, how to establish the agenda, how long to meet, how the choices are made, and with what consequences for whom are important political issues because they hold the potential for changing political relationships (eg among individuals, subunits within an organization, and headquarters and field offices of organizations) For example, the effects of these choices might reinforce the influence of established elites or open up communication to more 'pluralistic' interaction, and hence bring about a different play of politics and political outcomes Depending upon whether, and how, different organizational actors perceive the political impacts of change in communication, they will be more or less amenable to substitution

[13]Cordell and Stinson, *op cit*, Ref 1

At a more macro level, the politics of telecommunications arrangements can be a powerful factor influencing substitution For example, Johansen and his colleagues[14] suggest that·

> In countries like the United Kingdom, a single public corporation may have complete control over all person-to-person communication Such a corporation can block any new technology simply by refusing to adopt it or regulating against its use

While such institutional arrangements are commonly recognized as important influences, there has been no research or critical thought that might provide insight into how different arrangements might induce or inhibit substitution

Strategies for promoting telecommunications substitution

Alternative views of the government's role

There are two major views of the government's role in relation to increased use of telecommunications for achieving energy conservation The first is that *government intervention is required* in order to meet the opportunity and avoid the threats posed by telecommunications For example, Tyler *et al*, feel that energy conservation will *depend* upon government policy:

> the realization of the possible energy savings will depend on public policies The policies for transportation, telecommunications, urban and regional planning, and publicly funded research and development are all relevant [15]

The major reason given for government intervention is that while the energy savings from increased telecommunications usage on a national scale are substantial, the energy costs of travel by individuals and organizations are too small in themselves to induce the search for cost-saving alternatives even with currently rising energy and travel costs Indeed there is some support for this view in an empirical study of automobile travel behaviour, conducted during the 1974 energy crisis, which found that only social and recreational travel (primarily to and from rural areas) appeared sensitive to long lines, increased gasoline costs, and odd-even rationing [16]

A second major reason for government intervention is to help overcome the barriers to greater availability and use of telecommunications The notion is that the current limitations of the technology with respect to cost, ease of use, quality, and availability require government policy to spur greater telecommunications innovation and diffusion by industry on the one hand, and to promote greater use of available telecommunications technologies by government, business, and education on the other hand

The third reason for government intervention is that the major alternative, leaving decision and action up to market mechanisms, may fall short of the ideal either in efficiency (maximizing overall social welfare) or equity (ie the fair distribution of benefits and costs), or both.[17]

The alternative view of the government's role is that *intervention is not required* – indeed not desired The notion is that the market mechanism will take care of things: if suitable telecommunications alternatives to travel are available and if telecommunications substitution is cost-effective, then it will be adopted by individuals and organizations without government intervention Moreover, this view holds that the increasing

[14]Johansen *et al*, *op cit*, Ref 1

[15]M Tyler, M Katsoulis and A Cook, 'Telecommunications and energy policy', *Telecommunications Policy*, Vol 1, No 4, December 1976, p 30

[16]W C Lee, 'Demand for travel and the gasoline crisis', in *Transportation Energy Data, Forecasting, Policy, and Models*, Transportation research record 764, Transportation Research Board, National Academy of Sciences, Washington, DC, 1980, pp 38–42

[17]Harkness (*op cit*, Ref 1) identified three broad classes of market failures where government intervention might be warranted

'Information or organizational problems where, though a perfect market system would be expected to produce the desired outcome, the real market does not because decision makers are uninformed about the possibilities or unable to make suitable arrangements to undertake pioneering high-risk, high-reward ventures A related issue is the imperfect working of the market in an oligopoly where each may wait for the other to bear the risks of innovation In these cases, the promotional role of government, through research, information, and demonstration projects, can spur the market systems to seize opportunities that would otherwise only be perceived and developed slowly

Situations where the financial costs and benefits to each individual decision maker do not correctly reflect the costs and benefits because of distortions in the pricing systems For example, increased locational freedom may result in a greater than optimal degree of urban dispersal if prices charged for public utilities, such as electricity and gas do not, because of tariff averaging, fully reflect the cost of providing such services as dispersed, low-density locations Changes in regulatory policies could well be helpful here in terms of the fairness of the cost burden borne by different locations and socioeconomic groups, as well as dealing with the issues of economic efficiency and environmental quality raised by dispersal

Technological externalities cases where the impacts entail costs and benefits to parties not active in the market transactions that would in a laissez-faire situation determine the outcome A classic example of such an externality is the cost imposed on the community by pollution Two policy approaches to this type of problem can be attempted one (usually favoured by economists) is to attempt to adjust the working of the market by corrective taxes and subsidies that reflect the external costs and benefits, another is to supplant the workings of the market in the particular field under consideration by some degree of government regulation and planning '

energy and travel costs will be sufficient to stimulate high substitution effects

This view is by far the most popular among policy makers in the USA today, and has been since about the mid 1970s (this view is also currently characteristic of other areas of US policy) Although non-intervention is publicly justified on the 'market' argument, it might be privately justified on a political argument That is, advances in telecommunications pose such serious threats to the future of the transportation industries that no US policy official is willing to intervene directly, to benefit the telecommunications industry or to further the transportation industry's demise

For example, in his technology assessment of telecommunications and transportation interactions, Harkness[18] reported some dramatic impacts for the US transportation system With regard to teleconferencing and business travel, if total business air travel were reduced by 20%, this would result in an 8% reduction in total air travel but a more than 8% reduction in revenues since business people pay full fare Moreover, 'because teleconferencing is instantaneous, it might compete with and reduce the need for VSTOL and SST aircraft that cater to businessmen and officials whose time is considered valuable or who must meet quickly in crisis situations Regarding telecommunications and office relocation

> The extensive office growth officially predicted for many downtowns may not occur, thereby upsetting downtown redevelopment plans and jeopardizing center city fiscal plans based on assumptions about future growth and property receipts Low- or zero-growth CBDs would adversely affect patronage on rapid rail transit systems, perhaps turning them into white elephants, and increasing the national operating deficit on urban rail systems, which now runs about $500 million annually Conversely, tens of billions of dollars might be saved if the nation could avoid building new urban rail systems A preliminary cost analysis showed that providing new rapid rail and freeway systems for the 1 9 million additional CBD ofice workers expected by the year 2000 in United States cities that do not now have rapid rail would cost roughly $30 billion, whereas diverting them to the suburbs and using freeways would cost only $3 billion [20]

Finally, regarding telecommunications and neighbourhood office centres or work at home

> roughly $30 billion in otherwise necessary freeway expansions might be saved if all office employment growth expected in the 50 largest US cities by the year 2000 (twelve million employees) adopted telework rather than commuting to CBD and non-CBD offices by freeway [21]

Such potential impacts are not likely to be taken lightly by stakeholders in the transportation industries, and consequently, regardless of their potential net benefits for society as a whole, policy makers would be wary of proposals for direct government intervention to bring them about Indeed, the current lack of policy interest in the telecommunications substitution question is remarkable As noted by Harkness in his 1977 technology assessment of the interactions between telecommunications and transportation

> We found little understanding of [the] threats and opportunities within the research and policy communities, nor is there any focused institutional responsibility for investigating them Although DoT, HUD, NASA, GSA, DoC, NAE, and NSF all have sponsored investigations in this area, none has an overall responsibility for searching out the broad spectrum of telecommunications-dependent opportunities, nor for investigating subtle threats to the quality of life, the economy, and to other key areas [22]

[18] *Op cit*, Ref 1
[19] *Ibid*, lviii
[20] *Ibid*, lix
[21] *Ibid*, lxi
[22] *Ibid*, xii

Moreover, it appears that Harkness was aware of the growing non-intervention mood of federal policy makers when he next recommended·

> We therefore suggest the creation of a 'division' within some appropriate agency to serve as a focal point within government for information about new ways that telecommunication could be exploited for the general welfare and for investigating and monitoring the diffuse, long-term threats that may accompany them *This 'division' would sponsor research but not implement programs It would prepare an annual state of telecommunications message* for Congress and the executive branch, *but would have no regulatory power* [emphasis added][23]

This policy mood is in marked contrast to the 'blue-sky' thinking, experiments, demonstrations, and explicit promotion of telecommunications that characterized federal activity during the late sixties and early seventies [24] Whereas the previous policy was to stimulate, promote, and even regulate to advance telecommunications, the current policy is to remove government intervention in the telecommunications field whereever possible and to provide tax incentives and depreciation allowances that will allow the telecommunications industries (and other industries as well) to conduct needed research and development, to improve technology, make the investments in infrastructure required to deliver new technologies, and to promote their use through industry demonstrations, experiments, and publicity

Major mechamisms of government policy

Even the so-called 'non-intervention' strategy involves government policy in a way that potentially facilitates the telecommunications industry's development Therefore, it seems useful to review the major mechanisms of central government policy that might be applicable, whatever the strategy of any particular government The following basic mechanisms can be used by governments to influence market forces [26]

- Publicity and persuasion
- Research and development sponsorship
- Experiment and demonstration
- Subsidies and taxes
- Regulation and semidirect orders (a form of regulation in which the government, for example, requires contractors to use teleconferencing during performance of government contracts)

These will be discussed next in the context of specific policies for affecting telecommunications substitution

Policies affecting substitution

The substitution of telecommunications for travel would be encouraged by any policy that made telecommunications the most attractive choice The provision of transportation systems has historically received considerable financial support from, and often requires the approval of, federal, state, and local governments The existence of these financial and other supports to both the development and the operation of transportation systems has historically been justified as essential for the economic development (and the national security) of various nations Yet, recent research on the information economy indicates that many nations' potential for economic growth might, in the future, rely somewhat more on communications and somewhat less on transportation

[23] *Ibid*, lxii

[24] See, for example, the NSF-sponsored experiments and demonstrations with telecommunications applications in health care, education, office automation, etc NSF also sponsored the creation of telecommunications policy groups that might investigate needed/desirable policy interventions Other government agencies did likewise See *Telecommunications Policy Research Program Summary of Activities and Description of Research Projects/ Fiscal Years 1972–1975*, National Science Foundation, NSF 75–36, Washington, DC, 1975

[25] *Ibid*

[26] Harkness, *op cit*, Ref 1, Tyler *et al*, *op cit*, Ref 15, Johansen *et al*, *op cit*, Ref 1

In broad terms, substitution of telecommunications could be encouraged by any or all of three types of policy [27]

- Reduce the attractiveness of travel
- Encourage the development of telecommunications alternatives
- Ensure that corporate and business managers are fully informed of the comparative capabilities, costs, and benefits of telecommunications

The importance of considering these kinds of policy together is illustrated by the potential generation effects of telecommunications While research indicates that the initial effect of telecommunications is to reduce travel, ultimately it could increase travel demand A coherent policy approach therefore must be based on the realization that travel can *only* be increased if more transportation systems are provided for it If a decision to cease encouraging travel by building more transportation systems, or to discourage travel by higher taxes on fuel and transportation facilities, were matched with a decision to encourage telecommunications substitution, then increased telecommunications would be much more likely to reduce rather than increase travel, and thereby achieve its potential for energy conservation through substitution While politically difficult, and possibly not politically feasible such policy choice is important because it illustrates the strategic choices involved if, for example, energy scarcity becomes a serious threat

Policies to reduce the attractiveness of travel

The most obvious policy for reducing the attractiveness of travel involves the reduction of governmental funding support for the development, expansion, and operation of transportation facilities such as highways, freeways, mass transit, railroads, and airports Given the extensive existing network of such facilities in the USA, it can be argued that basic needs are well met and any further expansion could be financed through private sources,[28] increased user charges, or both

In addition to reduction of governmental spending for transportation, the rationing of transportation by the price mechanism could provide an incentive to induce substitution One policy option involves the use of economic incentives in the form of direct taxes, designed to increase overall transportation efficiency as well as induce telecommunications substitution by discouraging travel Tyler, *et al*,[29] suggested the following application of such policy to private car use

- The government could charge the buyer a lump-sum tax per vehicle bought This tax might, for example, be inversely related to the fuel consumption of the vehicle
- Governments could collect a tax from the automobile manufacturers based on the number of high gas-consuming vehicles produced in a given year, the tax would then be wholly or partly passed on to their customers
- An annual surtax imposed on the annual registration fee of larger-engine automobiles could be applied
- A system of penalties levied according to vehicle weight

Another policy option involving economic incentives would operate through higher fuel prices The deregulation of gas and oil prices, where regulation has operated in the past to keep transportation costs low, could provide a major stimulus for substitution Such policy is likely to

[27]Harkness, *op cit*, Ref 1

[28]In Orange County, California, consideration is being given to having construction of a new 26-mile freeway financed by the private developers who would benefit from such construction and who would in turn pass the cost on to new home buyers, businesses, and industries

[29]Tyler *et al*, *op cit*, Ref 15, p 31

have far more effect and be simpler to implement than tax policies such as those suggested above However, deregulation might not have dramatic effects in countries which have not kept oil and gas prices artificially low in the past.

Direct legal restrictions on automobile access to central business districts are another policy option for reducing the attractiveness of travel, but one which is likely to face enormous public resistance except in periods of energy scarcity Car pools, 'commuter computer' services, car pool lanes ('diamond' lanes), corporate van pools, extraordinary tolls on bridgs, highways and tunnels have been tried by many local governments in the USA and have had some success in reducing interurban travel.

Policies to encourage development of telecommunications alternatives

Clearly, policies to reduce the attractiveness of travel will encourage telecommunications substitution But by themselves, they might not be sufficient to encourage development of suitable telecommunications alternatives. Therefore specific policy options for encouraging substitution need to be considered with respect to: research and development, experiment and demonstration, subsidy and tax incentives, and regulation

Central governments have long provided direct and indirect support for industrial research and development through their role as 'leading edge' customer for new technology. For example, this policy has been characteristic of industrial innovation in the US computer industry[30] and currently exists with regard to the development of ICAD/ICAM (Integrated Computer Assisted Design/Integrated Computer Assisted Manufacturing) between the US Air Force, major manufacturers of military aircraft and equipment, and computer/factory automation companies [31] In this role, central governments not only provide direct funding support, but also provide operational test sites for advanced technologies and applications where industrial customers might not yet be ready Central governments have also traditionally played a role in funding basic research and advanced development activities in 'generic technologies' and in areas such as reliability, miniaturization, standardization and networking, which are common to many computer and telecommunications technologies and applications Finally, central governments have provided indirect support to industrial innovation by way of research and development monies made available out of the profits of standard computer and telecommunications products purchased by government agencies.

This policy of government-as-leading-edge-customer also relates to a second policy option – government support of experiment and demonstration with telecommunications As a leading-edge customer for new telecommunications alternatives, central governments can provide an initial market, facilitate perfection of new technologies and applications, and substantially reduce the risk in adoption by other government and corporate organizations Moreover, central governments can support similar experimentation and demonstration in other organizations and areas of application, such as those sponsored by the National Science Foundation, during the early 1970s, in telemedicine, citizen feedback, public service and cable television, and teleconferencing [32]

Generally, the results of such demonstrations have been mixed, and as a consequence research has been conducted into the conditions required for effective demonstrations A Rand Corporation[33] study of some 24 federally sponsored demonstration projects indicated that adoption of technical innovations requires that the demonstrations show that an

[30]K E Knight, G Kozmetsky, and H R Baca, *Industry Views of the Role of the Federal Government in Industrial Innovation*, Graduate School of Business, University of Texas, Austin, TX, 1976

[31]D Wisnosky, 'ICAM The Air Force's integrated computer-aided manufacturing program', *Astronautics and Aeronautics*, February 1977, pp 52–59, D B Dallas, 'The advent of the automatic factory', *Manufacturing Engineering*, November 1980, pp 66–76

[32]National Science Foundation, *op cit*, Ref 24

economic advantage exists Successful demonstrations tend to have the following attributes: the subject technology is well in hand, the demonstration involves cost- and risk-sharing with the participating organizations, the project initiative comes from non-central government sources, there exists a strong industrial system for commercialization; and there is an absence of tight time constraints on the demonstration The Rand study also concluded that demonstration projects should

- Have a narrow scope for effective use
- Have a well articulated market demand (rather than rely upon 'technology push')
- Not attempt to tackle institutional and organizational barriers to diffusion (other interventions, such as taxes and subsidies, are more effective than demonstrations in stimulating diffusion in such situations)

Thus, while experiments and demonstrations might be useful tools for stimulating telecommunications substitution, unless they are carefully designed and executed they may not be successful in achieving the desired effect

Subsidies and tax incentives represent another policy option for development of telecommunications alternatives to transportation. Such incentives can be provided not only to manufacturers of telecommunications equipment, but also to providers of infrastructure, to organizational users, and to individuals Currently in the USA, federal tax incentives, in the form of depreciation allowances for investment in capital facilities and tax reductions for investment in research and development, have positive implications for encouraging telecommunications substitution. Subsidies to communications common carriers, in the form of increased rates to provide capital for infrastructure investments, represent another major incentive However, there are few incentives for organizations and individuals at present The only federal encouragement to telework, for example, results from the tax advantages that might be obtained by those who are self-employed and who work at home [34]

Regulation of common carriers represents another policy option for encouraging telecommunications substitution, but it is unclear how the 'new' regulatory policy environment in the USA might be further shaped to do so Most of the recent studies of telecommunications–transportation substitution shy away from consideration of regulatory policy For example, Tyler *et al*[35] say

> A policy of telecommunications substitution does not necessarily make any demands on the telecommunications common carrier beyond the willingness to provide teleconference services, and the infrastructure for the office-automation services needed for workplace dispersal when necessary

Possibly, this stance is taken because telecommunications regulatory policy in the USA did a complete 'about-face' from policy directed toward emphasis on aggregative procedures, control and stability to policy that permits competition in both the terminal equipment and transmission service areas Terminal equipment currently is subject to open entry and soon will be deregulated Beyond-local transmission has been opened up to competition, new network interconnected terrestrial and satellite systems have been constructed, resale of traditional monopoly services is under consideration, and local data transmission regulatory policy is under re-examination One result is that 'firms such as

[33]W S Baer, L L Johnson, and E W Merrow, *Analysis of Federally Funded Demonstration Projects Final Report*, The Rand Corporation, Santa Monica, CA, R-1926-DC, 1976
[34]Harkness, *op cit*, Ref 1
[35]Tyler *et al*, *op cit*, Ref 15, p 32

MCI, ITT, Southern Pacific, IBM and Xerox are emerging as formidable and pervasive competition for the established telephone carriers' Another result is that the 'established carriers today are falling over one another in an attempt to serve emerging data, voice, facsimile, and other subscriber demands' [36]

It seems unlikely that it will be possible to simply rely on open entry to provide an adequate environment for telecommunications substitution For example, engineering standards set to ensure compatible development of each firm's technical interfaces will be needed Some regulation also will be needed to encourage stability in the planning and construction of facilities However, these and other possible areas of regulation are so heavily dependent upon the characteristics and evolving policy of a given country that it is difficult to suggest further regulatory policy options

Finally, substitution might be encouraged by a wholly different type of regulation, in the form of 'semi-direct orders' aimed at government contractors by government agencies The contractors would be required to use teleconferencing or other forms of telecommunication in place of travel during the performance of government contracts There is some reason to believe that such policies might be effective for some tasks in situations involving multiple contractors in geographically spread locations working on a common project over a long period

Policies to inform decision makers

The various attitudinal studies of telecommunications substitution clearly indicate that corporate and business managers and the general public are largely unaware of the availability of substitute services, what they entail, and their individual and organizational costs and benefits Moreover, many corporate and government managers are used to a travel-intensive workstyle and are encouraged in that mode of thinking by widespread publicity from the transportation industries Policies to inform decision makers about the logic of telecommunications substitution might help to instil it in the current mode of thinking

In addition to publicity and promotion, experiments and demonstrations, policies might be adopted to support more intensive telecommunications policy research A focus of such research would be empirical policy-oriented study of existing operational systems (or new systems) with a view towards systematic assessment of the costs and benefits (broadly conceived), implementation issues and strategies, and *policy options and consequences for individuals and organizations* Another focus of such research would be on how existing and changing social and organizational arrangements might interact with telecommunications in the future, perhaps providing impetus for greater substitution, perhaps creating threats and barriers to it Particular emphasis would be given to *individual and institutional incentives* which drive how telecommunications will be used in society (eg the factors driving how multinational corporations will utilize the technology, the factors driving how urban form will evolve and interact with telecommunications, the factors driving a movement to satellite business centres and neighbourhood work centres)

Conclusion

The real energy conservation that might result from telecommunications substitution for transportation remains difficult to predict. While estimates range from 'one to three percent of total energy consumption, or

[36] W Bolter, 'Is there a future for regulation in the future of telecommunications?' paper presented at the Eighth Annual Telecommunications Policy Research Conference, Annapolis, MD, April 27–30, 1980

up to five percent of petroleum consumption', the margin of error in such estimates is at least as large as the estimated energy savings, due to the problematic assumptions and data on which they are based

The real potential of telecommunications as a substitute for travel also remains difficult to predict While attitudinal research shows that potential substitutability of 20 to 30% exists, the operational studies have failed to clearly demonstrate that travel reduction or travel avoidance has occurred with existing telecommunications systems

The 'substitution logic' depends upon a number of factors which influence which individuals and institutions will in fact choose telecommunications over travel While there might be others, six major factors seem to be the nature of the meeting or work for which telecommunications will be used, the quality and availability of the technology, the comparative cost of the alternatives, the individual and organizational incentives for substitution, the availability and cost of energy, and the politics of communications and of telecommunications arrangements

New developments in telecommunications technology, such as satellite systems, continually rising energy and travel costs, and the prospect of substantive increases in worker productivity as well as competitive gains from telecommunications, might tip the scales in favour of telecommunications for some kinds of travel to meetings and for some classes of work But the shift will not be dramatic or quick – certainly not to the extent or in the timeframes predicted by enthusiasts

Government policy can facilitate telecommunications substitution for travel Indeed, some observers feel that substitution depends upon proactive government policy The substitution of telecommunications for travel would be encouraged by any policy that made telecommunications the most attractive choice There is a basis for such policy in most developed nations, which historically have provided financial and other supports for the development and operation of transportation systems as essential for economic development, given that the potential of many nations for economic growth might in the future rely somewhat more on communications and somewhat less on transportation. In broad terms, telecommunications substitution could be encouraged by any or all of three types of policy· (1) reduce the attractiveness of travel, (2) encourage the development of telecommunications alternatives, and (3) ensure that corporate and business managers, and the public, are fully informed of the comparative capabilities, costs, and benefits of telecommunications and transportation The options and mechanisms related to each type of policy are many, but must be considered in the context of each country's political, economic, regulatory and social development